Appendix B

TECHNICAL MEMORANDUM

TO: Mr. James Faber (LAN Engineering Corp.)

FROM: Brad Newton, Alexander Pappas, Joel Degner (SAIC)

RE: Amargosa Creek Percolation Demonstration

DATE: July 2, 2007

INTRODUCTION

SAIC was retained to provide hydrologic and engineering data review, and preliminary percolation test services to Lim and Nascimento Engineering (LAN) on behalf of their client, the City of Palmdale. In this technical memorandum, SAIC is providing to LAN Engineering a preliminary report of the recharge potential through water percolation proximal to the Amargosa Creek at the 20th Street West crossing ("Site 1") and proximal to the Amargosa Creek at the 25th Street West crossing ("Site 2"). The following details the results and methodology of the percolation demonstration tests.

RESULTS

At Site 1, the average percolation rate was 11.0 feet per day (ft/day) during the stabilized period of the demonstration, with a maximum of 11.9 ft/day and a minimum of 10.2 ft/day (Figure 1, Table 1). At Site 2, the average percolation rate was 2.4 ft/day during the stabilized period of the demonstration, with a maximum of 3.1 ft/day and a minimum of 1.1 ft/day (Figure 2, Table 2). We suggest for the estimation of percolation potential a value of 11.0 ft/day be used to represent pit one and a value of 2.5 feet per day be used to represent pit two. While we have measured the percolation rate for these sites during our demonstration tests, over the long term of months and years, percolation rates would likely be less than the values measured during the demonstration.

METHODOLOGY

SAIC conducted two demonstration tests of percolation to the unconfined aquifer under the Amargosa Creek to quantify the potential recharge to the regional groundwater aquifer. Two percolation pits were constructed using a back hoe. Site 1 is located at N 34° 35′ 19.3", W 118° 10′ 01.7"north-west of the proposed 20th Street crossing the Amargosa Creek at Elizabeth Lake Road, and Site 2 is located at N 34° 35′ 01.3", W 118° 10′ 34.2"south-west of the 25th Street crossing of the Amargosa Creek at Elizabeth Lake Road.

Pits were constructed as follows:

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- Each pit was excavated to the dimensions of 20 feet (ft) by 20 ft and 3 ft deep with vertical sides. Both pits were located within the floodplain of the Amargosa Creek.
- The sediments excavated at Site 1 were very fine silty sands with a 1 foot surface layer of a sandy gravel deposit, and at Site 2 were very fine silty to clayey sands with a 1 foot surface layer of very fine silty to clayey sands with gravels and cobbles interspersed throughout; these are consistent with the sediments documented in the report titled, "Geotechnical Investigation Proposed Bridge 20th Street West at Amargosa Creek Improvements City of Palmdale, California", prepared by Group Delta Consultants, Inc., prepared for Lim and Nascimento Engineering dated March 24, 2006.
- A graduated staff was anchored into the bottom of each pit near enough to the edge for visual observations of water depth.
- Fire hydrants located near each pit were used to supply water. A 2.5 inch diameter hose conveyed water from the hydrants to the pits. A water meter and valve was attached to the hose to record and regulate the volume of water delivered to the pit. The water was dispersed via a "trash screen" attached to the end of the hose to prevent erosion within the pit.

Percolation demonstration methodology:

- Each pit was filled with water to a depth of 1.1 ft; the volume of water required to fill the pit to 1.1 ft was noted.
- The flow rate was adjusted as needed in order to maintain a constant water depth of 1.1 ft, plus or minus 0.005 ft.
- The flow volume required to maintain the constant water depth was recorded in increments sufficiently spaced to evaluate changes in percolation rates. The maximum interval between readings was one hour (hr). Each pit was closely monitored during the entire duration of the tests.
- Each test was conducted for a minimum duration of 24 hours (hrs) and until a stable percolation rate occurred.
- The percolation rate in feet per day for each measurement interval was determined using the following equation:
  - $$Percolation\left(\frac{ft}{day}\right) = \frac{\left(\frac{(Water\ added\ (ft^3)) + (Change\ in\ depth\ (ft^3))}{Area\ of\ Pit\ (ft^2)}\right)}{Time\ (hr)} * 24\ \frac{hrs}{day}$$
- Percolation rates were then plotted against time to determine when the percolation rate was stable. Tests were stopped when the duration of the test exceeded 24 hrs and the trend in percolation rates stabilized.

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- Average percolation rates were calculated considering all data points after which stabilization had been reached.

DISCUSSION

The final percolation rate for each pit was determined by closely monitoring the change in percolation rates over the length of the tests. For pit one, stabilization occurred after 7 hours and for pit two, stabilization occurred after 7.5 hours. The final percolation rate was calculated by averaging the percolation rates from stabilization until termination of the test. For pit one, the average percolation rate was 11.0 ft/day, with a maximum of 11.9 ft/day and a minimum of 10.2 ft/day. For pit two, the average percolation rate was 2.4 ft/day, with a maximum of 3.1 ft/day and a minimum of 1.1 ft/day. We suggest for estimation of percolation potential a value of 11.0 ft/day be used to represent pit one and a value of 2.5 feet per day be used to represent pit two. While we have demonstrated the final percolation rate for these sites during a 24 hr period, over the long term of months and years, percolation rates would likely be less than the values measured during this demonstration.

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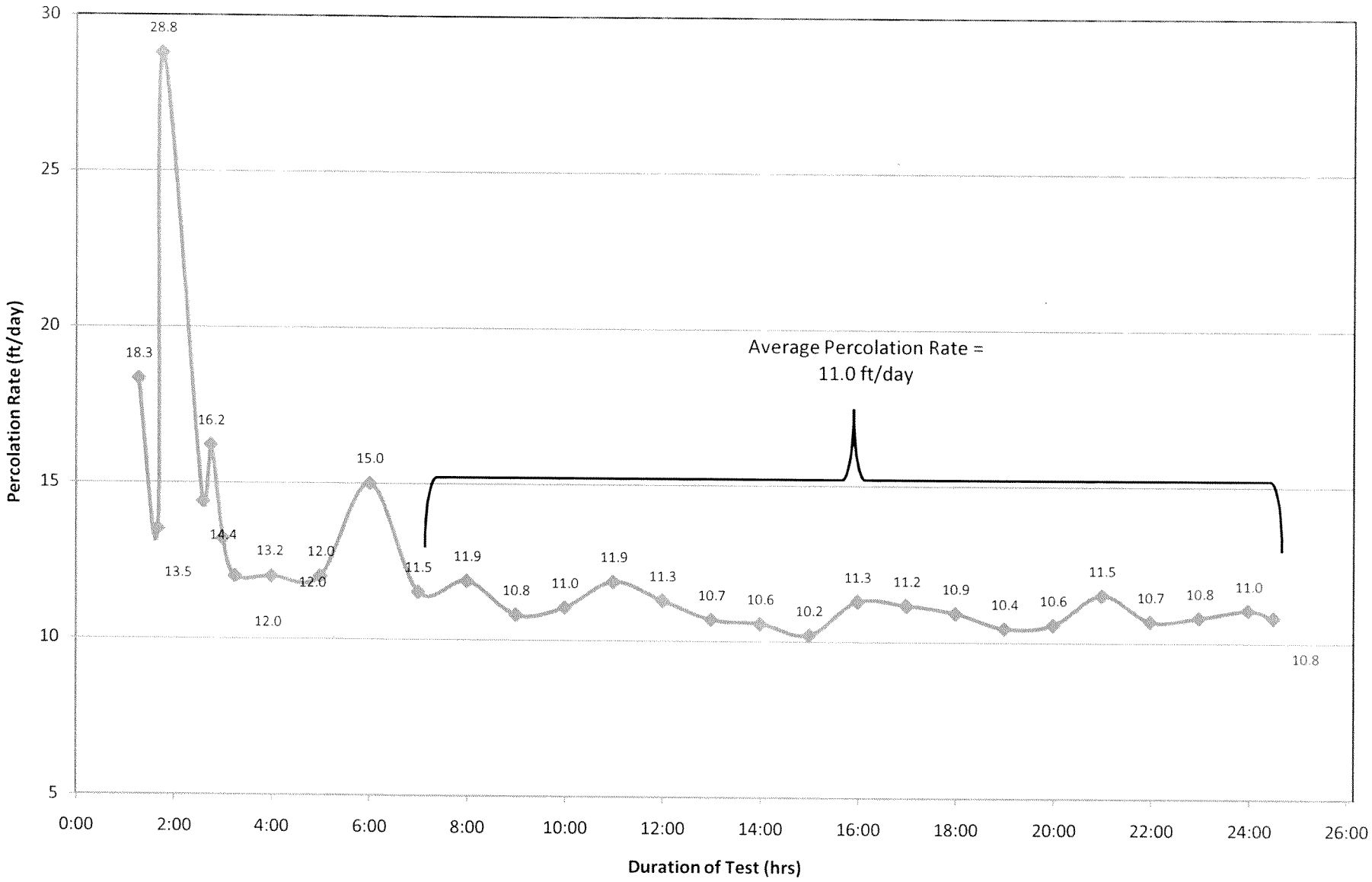
Site 1: North-West of Proposed 20th Street Crossing



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2007-29-07 field_data F1.xls

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FIGURE 1
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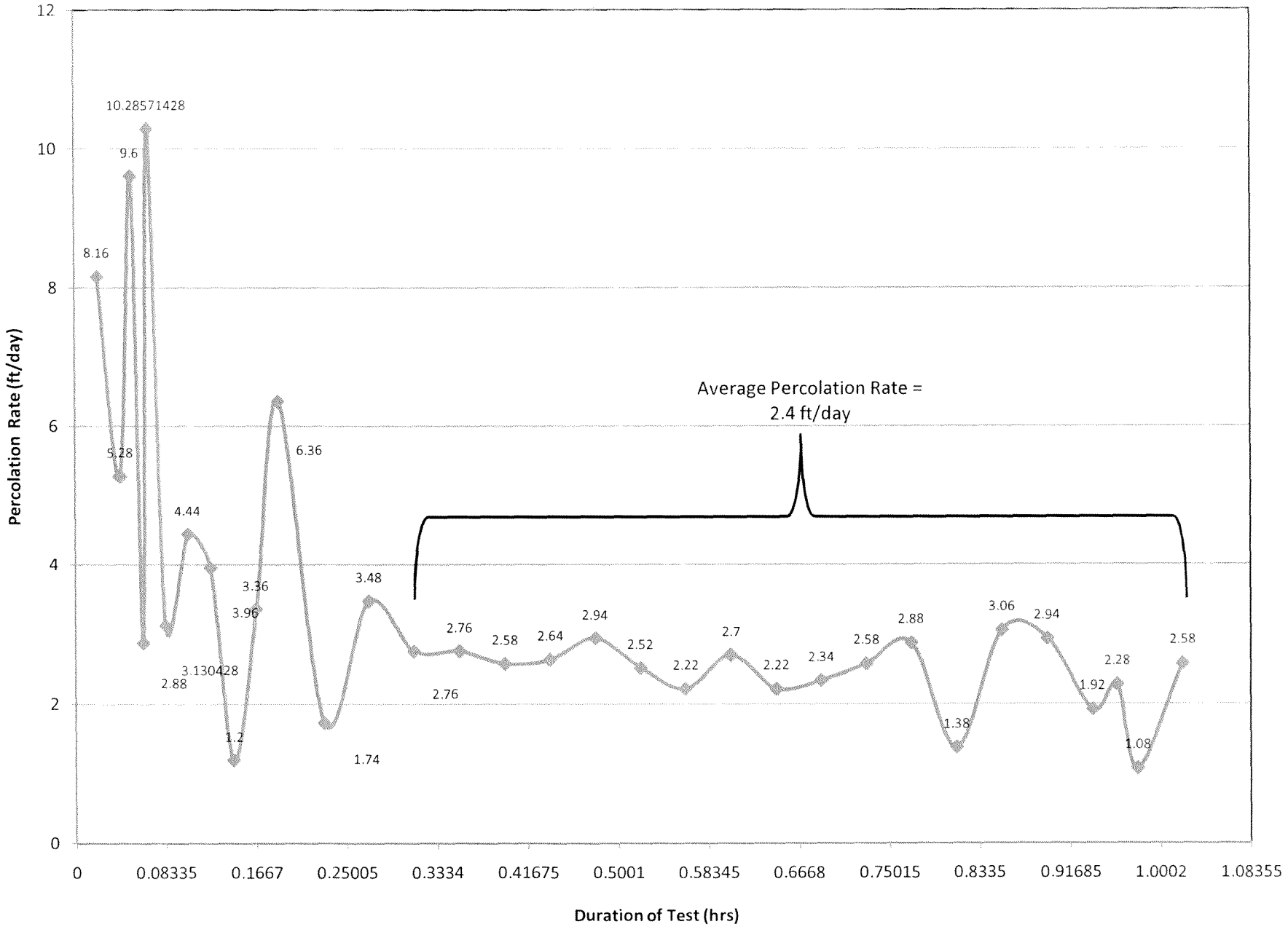
Data Table
Site 1: West of Proposed 20th Sreet Crossing

Duration of Test (hr)	Meter Reading (ft^3)	Staff Height (ft)	Change in Depth (ft^3)	Volume of Water Percolated (ft^3)	Percolation Rate (ft/day)
0:00	361940	0	--	--	--
0:50	362520	1.1	--	--	--
1:16	362670	1.1	0	150	18.3
1:40	362760	1.1	0	90	13.5
1:45	362800	1.1	0	40	28.8
2:35	363000	1.1	0	200	14.4
2:45	363045	1.1	0	45	16.2
3:00	363100	1.1	0	55	13.2
3:15	363150	1.1	0	50	12.0
4:00	363300	1.1	0	150	12.0
5:00	363500	1.1	0	200	12.0
6:00	363750	1.1	0	250	15.0
7:00	363950	1.12	-8	192	11.5
8:00	364140	1.1	8	198	11.9
9:00	364320	1.1	0	180	10.8
10:00	364500	1.09	4	184	11.0
11:00	364710	1.12	-12	198	11.9
12:00	364890	1.1	8	188	11.3
13:00	365060	1.08	8	178	10.7
14:00	365240	1.09	-4	176	10.6
15:00	365410	1.09	0	170	10.2
16:00	365590	1.07	8	188	11.3
17:00	365800	1.13	-24	186	11.2
18:00	365970	1.1	12	182	10.9
19:00	366140	1.09	4	174	10.4
20:00	366320	1.1	-4	176	10.6
21:00	366520	1.12	-8	192	11.5
22:00	366690	1.1	8	178	10.7
23:00	366870	1.1	0	180	10.8
24:00	367050	1.09	4	184	11.0
24:30	367140	1.09	0	90	10.8

Site 2: South-West of the 25th Street Crossing



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2007-29-07 field_data F2.xls

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FIGURE 2
7/3/2007

Data Table

Site 2: West of the 25th Sreet Crossing

Duration of Test (hr)	Meter Reading (ft^3)	Staff Height (ft)	Change in Depth (ft^3)	Volume of Water Percolated (ft^3)	Percolation Rate (ft/day)
0:00	367120	0	--	--	--
0:15	367510	1.1	--	--	--
0:30	367540	1.09	4	34	8.2
1:00	367660	1.28	-76	44	5.3
1:15	367660	1.18	40	40	9.6
1:30	367660	1.15	12	12	2.9
1:37	367660	1.1	20	20	10.3
2:00	367680	1.1	0	20	3.1
2:30	367717	1.1	0	37	4.4
3:00	367750	1.1	0	33	4.0
3:30	367760	1.1	0	10	1.2
4:00	367780	1.08	8	28	3.4
4:30	367845	1.11	-12	53	6.4
5:30	367870	1.1	4	29	1.7
6:30	367928	1.1	0	58	3.5
7:30	367974	1.1	0	46	2.8
8:30	368020	1.1	0	46	2.8
9:30	368063	1.1	0	43	2.6
10:30	368107	1.1	0	44	2.6
11:30	368156	1.1	0	49	2.9
12:30	368198	1.1	0	42	2.5
13:30	368227	1.08	8	37	2.2
14:30	368284	1.11	-12	45	2.7
15:30	368317	1.1	4	37	2.2
16:30	368356	1.1	0	39	2.3
17:30	368403	1.11	-4	43	2.6
18:30	368447	1.1	4	48	2.9
19:30	368470	1.1	0	23	1.4
20:30	368521	1.1	0	51	3.1
21:30	368570	1.1	0	49	2.9
22:30	368602	1.1	0	32	1.9
23:03	368640	1.1	0	38	2.3
23:30	368658	1.1	0	18	1.1
24:30	368701	1.1	0	43	2.6

TECHNICAL MEMORANDUM

TO: Gordon Phair, P.E. (City of Palmdale)

FROM: Drew Beckwith, Brad Newton, Ph.D., P.G. (SAIC)

RE: Amargosa Creek Recharge Project - Project Narrative

DATE: January 09, 2008

INTRODUCTION

This technical memorandum presents an overview of the Amargosa Creek Recharge Project - Conceptual Design, described in greater detail in the four topical technical memoranda that follow. The Amargosa Creek Recharge Project will provide the Antelope Valley with increased groundwater supplies and give local citizens a precedent-setting creek-side Nature Park (Figure 1). The recharge facility is envisioned to capture water supplies available from the California State Water Project (SWP) and storm flows originating from the Amargosa Creek watershed, and to percolate these waters into the Antelope Valley aquifer so the water may be extracted for beneficial use. In addition to providing groundwater recharge, the Amargosa Creek Recharge Project also provides a community Nature Park, inviting local citizens to exercise, relax, and learn about their natural surroundings.

The recharge facility conceptual engineering design utilizes pre-existing, in-stream bladed recharge areas and provides more than twelve additional acres of groundwater recharge basins (Figure 2). Six off-stream basins and two in-stream basins maximize land use for recharge on the north side of Elizabeth Lake Road. The recharge basins will be supplied with SWP water and runoff from the Amargosa Creek watershed. These diversions will be conveyed via closed pipes to recharge basins, ensuring a safe water delivery system. The recharge basins will incorporate curvilinear berms, native vegetation, and a multi-use bike path to integrate the recharge facilities with the Nature Park.

The Nature Park development will rehabilitate and enhance native habitat throughout, and specific plant species adapted to the desert environment will be planted on various terraces. More than four miles of multi-use bike pathway will provide public access, and will strategically link existing trails and bike pathways throughout the City and builds on the community's current use of the area. Pathways will weave through the Nature Park and around the recharge basins and be illuminated with solar-powered lights. At strategic locations along the path, education centers and interpretive plaques will provide information on the desert environment, urban runoff, watershed processes, and the recharge facilities.

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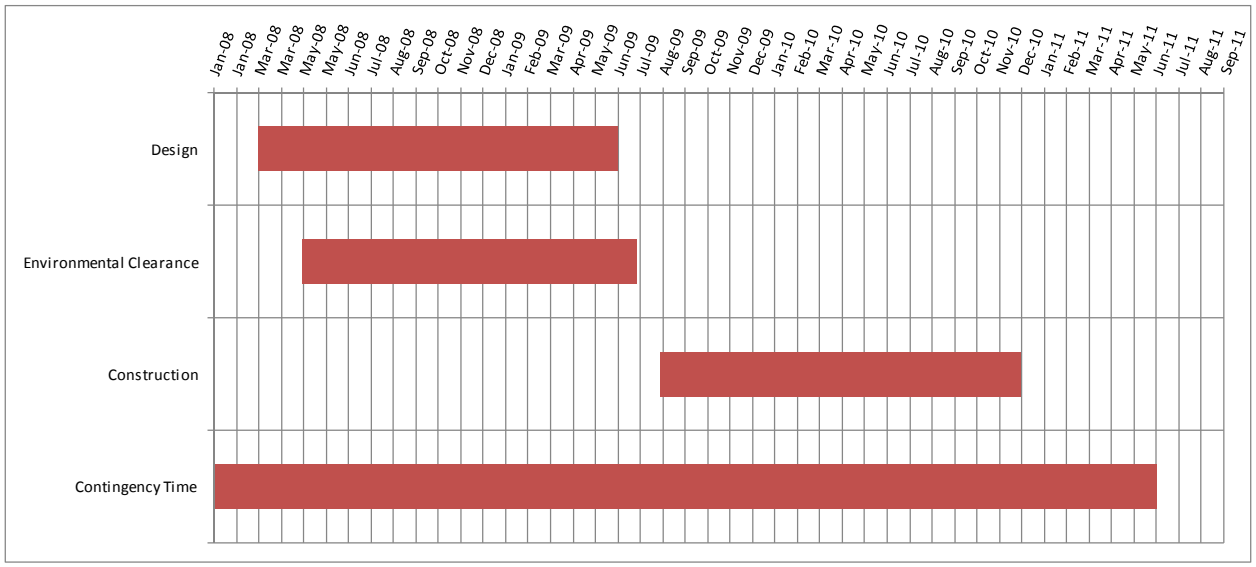
Additionally, ramadas and picnic tables located throughout the park will invite community members to sit down, relax, and enjoy their natural surroundings.

The cornerstone of the community Nature Park (Figure 3) is a three-acre parcel of "Heritage Habitat" that will preserve centuries-old Joshua and Juniper trees on-site. Located on the north side of Amargosa Creek, the Heritage Habitat will be accessed by three foot paths lined with plant identification placards and interpretive storyboards.

The Amargosa Creek Recharge Project will become a model for multi-use parks in a desert environment. The project will improve the regional water resource supply, promote further preservation of the Amargosa Creek corridor, provide the community at large with an accessible place to recreate, and encourage citizens to conserve their precious water resources.

The following schedule of activities is anticipated to describe the general and probable sequence of events and durations of stated activity. At this stage in the development of the project, uncertainties exist that increase the variability regarding start date, duration, and the date of first percolated water.



Four technical memoranda follow from this overview: Park Design Rationale, Engineering Conceptual Design and Rationale, Habitat Restoration and Enhancement Design Rationale, and Institutional Considerations. All memoranda reference Figures 1 – 6 and Table 1.

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TECHNICAL MEMORANDUM

TO: Gordon Phair, P.E. (City of Palmdale)

FROM: Drew Beckwith, Brad Newton, Ph.D., P.G. (SAIC)

RE: Amargosa Creek Recharge Project – Park Design Rationale

DATE: January 03, 2008

INTRODUCTION

The Amargosa Creek Nature Park (Nature Park) integrates the recharge facilities and habitat restoration of the Amargosa Creek Recharge Project (Figure 3). The 25-acre Nature Park will provide the community with a precedent-setting recreation facility that protects and increases access to open space, and preserves and enhances the desert scrubland with native plantings; and includes amenities such as a multi-use bike path and trail providing access to the park interior, interpretive signs and placards to inform and educate visitors, and multiple park benches, ramadas, and picnic tables for places of rest and conversation.

PARK AMENITIES

More than four miles of multi-use paved bike path will weave through the Nature Park and be illuminated with solar-powered lights. Unpaved trails will provide access to the sensitive Heritage Habitat and provide multiple routes for traveling through the Nature Park to enhance the park visitor's experience. The bike path will be located predominantly in the stable riparian zone and on top of engineered berms that create recharge basins. Solar-powered lights will provide illumination throughout, thus capitalizing on a renewable energy source and reducing the costs of electrical utility installation.

Educational centers and interpretive signs placed at strategic locations along the path and trail will provide information on the desert environment, native plants and animals, urban runoff, watershed processes, and the recharge facilities. Visitors will have the opportunity to learn about the surrounding environment and the value of the park as they grow to understand its uniqueness. This valuation is intended to translate to ownership, and create local stakeholders that protect and treat the park with care. This emergent stewardship of community assets will be a key factor in attaining long-term sustainability of the Nature Park.

Covered ramadas and picnic tables located throughout the park at prime viewing locations will invite community members to sit down, relax, and enjoy their natural surroundings. The angled, slatted-roof design of the ramadas and over picnic tables will

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provide shade and allow continuous airflow through the structures, making them comfortable during the mid-day sun.

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TECHNICAL MEMORANDUM

TO: Gordon Phair, P.E. (City of Palmdale)

FROM: Matthew Brown, P.E., Brad Newton, Ph. D., P.G. (SAIC)

RE: Amargosa Creek Recharge Project – Engineering Conceptual Design and Rationale

DATE: January 02, 2008

INTRODUCTION

This memo describes the conceptual engineering design of the Amargosa Creek Recharge Project and provides related engineering design rationale used as the basis for the conceptual design. The following sections describe general project goals, objectives, constraints, and engineering design features conceptualized for the project. This memo also provides recommendations for further activities to be pursued prior to final design activities.

PROJECT GOALS AND OBJECTIVES

The primary goal of the Amargosa Creek Recharge Project is to provide a facility, to be constructed on a site and owned by the City of Palmdale, that maximizes the potential for groundwater recharge of surface water supplies originating from the California Aqueduct and Amargosa Creek watershed. Preliminary design is scheduled to commence in early 2008; construction is scheduled to commence in early 2009. Primary objectives of the recharge project are to:

- Maximize the potential for groundwater recharge;
- Adhere to local building codes and zoning regulations;
- Adhere to local, state, and federal environmental regulations;
- Provide harmony between the project and adjacent land uses;
- Minimize adverse impact to local cultural and natural resources;
- Minimize initial and life-cycle project costs – construction, operation, maintenance.

PROJECT CONSTRAINTS

Primary constraints of the Amargosa Creek Recharge Project include:

- Groundwater percolation/storage capacity;
- Surface water availability/quality;
- Environmental Constraints;
- Institutional Constraints;
- Economic Constraints;
- Legal Constraints.

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RECOMMENDATIONS

1. Phase preliminary and final design and construction activities.
2. Recommended activities to complete prior to preliminary engineering design activities in general order of priority:
   a. Commence state environmental documentation and local public involvement;
   b. Complete a comprehensive topographic and location survey;
   c. Complete a comprehensive geologic, hydrogeologic, and percolation investigation;
   d. Complete a comprehensive hydrologic investigation of Amargosa Creek watershed;
   e. Complete a comprehensive geotechnical site investigation;
   f. Complete an evaluation of institutional considerations and water availability;
   g. Conduct multiple pilot tests of field percolation at the recharge site;
   h. Conduct hydraulic modeling of project surface water features.

ENGINEERING DESIGN FEATURES

Primary engineering design features of the Amargosa Creek Recharge Project include recharge basins and water collection and conveyance facilities. The following sections describe those features and the engineering design rationale used for the conceptual design. **It is recommended that preliminary and final design and construction activities be managed in a phased approach with specific milestones to allow educated decisions to be made prior to proceeding to the next phase. It is recommended that required environmental documentation and local public involvement be pursued as early in the design process as possible to ensure proper consideration for potential impacts to cultural and natural resources.**

A plan view layout of engineered facilities (Figure 2) and artist renderings (Figures 4-6) of project features are provided at the end of this Technical Memorandum. As portrayed on Figure 1, the project site includes existing undeveloped parcels proximal to Amargosa Creek north of Elizabeth Lake Road from the planned 20th Street West Bridge in a southwest direction approximately 3,000 feet to the existing 25th Street Bridge, and then west approximately 2,700 feet to its western edge near the California Aqueduct. Currently, the City of Palmdale owns all but one of these parcels, which the City is currently in negotiations to acquire. **It is recommended that a comprehensive topographic and location survey be performed prior to preliminary engineering design activities.**

Recharge Basins

The primary features of the project include: 1) five off-channel recharge basins (approximately 12 acres combined) located east of 25th Street West and north of Amargosa

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Creek that are intended to provide for the percolation of water delivered by pipeline from upstream diversions from Amargosa Creek and the nearby California Aqueduct; and 2) two in-channel recharge basins (approximately 5 acres combined) located immediately west of the 25th Street West Bridge and north of Elizabeth Lake Road that are intended to provide for the percolation of impounded Amargosa Creek flow using low-head dam structures in a stream reach that is relatively wide, allowing stream flow to be spread over a large area. The project may include diversions of water from the California Aqueduct into the Amargosa Creek channel upstream from the two proposed in-channel recharge basins to provide for in-channel recharge of State Water Project (SWP) water. The project would also include a 1.5-acre settling basin east of 25th Street West to allow sediment to settle out of any water diverted from Amargosa Creek.

The proposed number of off-channel basins (5) and the size of each basin (approximately 2 to 3 acres each) would provide relatively like-sized basins that can be operated in an alternating active/inactive status for flexibility in maintenance and operation of basins. This would allow any basin(s) to be taken out of service (held inactive) to remove sediments from percolation beds (maintenance) while other basins remain active. Standard operations would allow for a basin cleaning frequency where the ratio of active to inactive recharge area is approximately 2:1.

Geotechnical Considerations

Recharge basins have been chosen for the conceptual design because the local soil and geology conditions are conducive to high rates of water percolation. Preliminary percolation tests completed at two locations in the area verify high infiltrability and indicate percolation rates between two and eleven feet per day. The soils identified in the test pits included very fine silty to clayey sands with sandy gravels and cobbles near ground surface. **It is recommended that a comprehensive geologic and hydrogeologic report be produced (including additional field percolation tests for proposed recharge basin locations) prior to preliminary design activities. It is further recommended that consideration be given to pilot tests of field percolation prior to construction build-out.**

The proposed location of off-channel recharge basins has been chosen to maximize recharge area within project property boundaries and, to the extent possible, minimize basin berm erosion and maintenance activities. The off-channel basins would be constructed by earthwork activities that optimize cut and fill balances and minimize material and construction costs. Sale of excess earthen material could assist in offsetting project costs. The recharge basins would include interior and exterior earthen berms to contain and compartmentalize recharge water. The total exterior perimeter of proposed recharge basins is expected to be approximately 5,500 feet; total interior berm length is expected to be approximately 1,300 feet. Basin berm height and bed elevations would be set during preliminary design activities to optimize

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percolation, ensure conveyance to all basins by gravity flow, and protect against inundation and erosion from flow within Amargosa Creek.

Basin berms would provide multiple functions including retention of water within the basins, protection against erosive wave action within the basins and Amargosa Creek flood flows outside the basins, and foundation for roadways between and around the basins for municipal vehicles and maintenance equipment and multi-use bike paths. Potential geotechnical concerns associated with the berms would include soil erosion, slope instability, excessive seepage, or excessive settlement. Primary engineering properties of soils to be investigated would include shear strength, permeability, and bearing capacity. Potential solutions to geotechnical concerns would include manipulation of berm geometrical configurations and mechanical stabilization methods. General recommendations for berm configurations would include a 15-foot top width, 3:1 side slopes, and a two- to three-foot freeboard. Mechanical stabilization methods for slopes, embankments, and berms would include soil replacement or mixing if necessary, soil compaction (95% minimum), gravel/rip-rap/gabion armoring, or geosynthetic reinforcement. **It is recommended that a comprehensive geotechnical site investigation be performed to quantify specific engineering properties of site soils for preliminary design of geotechnical project features.**

Water Collection Facilities

The project considers two primary sources of water: State Water Project (SWP) water from the California Aqueduct and surface water from Amargosa Creek watershed. Project effectiveness will depend on water availability (source, timing, flow rate) and water quality from both sources.

SWP Water Diversion

The California Aqueduct lies immediately west of the project site, extending in a north-south manner, and crossing Elizabeth Lake Road with an existing inverted siphon (Leona Siphon). The project would include a mechanical tap into existing surface piping associated with the siphon located approximately 350 feet west of the western edge of the project site and immediately north of Elizabeth Lake Road. Substantial head pressure in the siphon would be used to pipe the SWP supply under pressure to the recharge basins located east of 25th Street West. The timing, flow rate, and institutional issues associated with SWP water supply from the California Aqueduct are currently being studied. SWP water quality is expected to be sufficient to forego treatment prior to groundwater recharge, but should be studied further for verification. **It is recommended that a comprehensive evaluation of institutional considerations and water availability be completed to quantify available SWP water for the project.**

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Amargosa Creek Water Diversion

The project also includes a secondary source of water from Amargosa Creek watershed for percolation in the two proposed in-stream recharge basins located west of 25th Street West and for pipeline conveyance under gravity flow conditions to the five off-stream recharge basins located east of 25th Street West. Amargosa Creek flow is ephemeral with occasional high-flow conditions. West (2006) reports a 100-year peak flow rate in Amargosa Creek at the project site of 2,350 cubic feet per second. **It is recommended that a detailed report be produced to describe long-term hydrologic conditions in Amargosa Creek at the project site and that consideration be given to hydraulic modeling of project surface water features prior to final design activities.**

Primary water collection facilities would include two low-head dams (approximately 300 feet total length) to impound water for the two proposed in-channel recharge basins and one 100-foot-length low-head dam located immediately upstream of the existing rip-rap drop structure in the creek bed to control hydraulic head for diversion from Amargosa Creek into the proposed gravity flow pipeline. The dams are expected to be less than three feet in height. Options for dam structures include gravel push-up dams (relatively low cost and high maintenance), flashboard dams (relatively medium cost and medium maintenance), and inflatable dams (relatively high cost and low maintenance). Representatives from the City of Palmdale have identified gravel push-up dams as the preferred initial alternative to provide a low-cost means of testing the system prior to installation of more costly dam structures. Water diversion from Amargosa Creek would be controlled by a concrete surface intake structure and slide headgate proposed to be located immediately upstream of the aforementioned low-head dam and creek bed drop structures. Elevation of the intake structure and headgate would be set for submerged conditions under specific stream flow conditions to allow gravity pipe flow of water diverted from Amargosa Creek to off-stream recharge basins located east of 25th Street West.

Habitat Restoration Water Supply

It is understood that project areas between Elizabeth Lake Road and Amargosa Creek will be planted with native plant species for the purpose of habitat restoration and a municipal nature park. It is also understood that the vegetation planned for this area will require irrigation during the vegetation establishment period. Water supply options for vegetation establishment include tapping into existing municipal water supplies near Elizabeth Lake Road, tapping into the proposed SWP pressure pipe planned for the recharge project, or tapping into proposed recycled water system to be located along 25th Street West currently being considered by the City of Palmdale.

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Water Conveyance Facilities

Proposed water conveyance facilities would include a dual pipe system, one pressure pipe from the SWP tap (SWP pressure pipe) and one gravity flow pipe from the proposed Amargosa Creek diversion headgate (Amargosa gravity pipe), both extending to the proposed off-channel recharge basins located east of 25th Street West. Sizing of the pipes would consider planned flow rates to accommodate maximum recharge capacity of the basins. Based on the proposed conceptual area of recharge and preliminary field data associated with expected basin percolation rates, the Amargosa gravity pipe would be sized on the order of 33 inches in diameter. The SWP pressure pipe would be sized after water amount and availability studies are completed.

SWP Pressure Pipe

The SWP pressure pipe would extend from the proposed tap eastward and parallel to the northern edge of Elizabeth Lake Road approximately 1,500 feet, then northward approximately 300 feet across Amargosa Creek near the proposed stream diversion structure, from which point, the SWP pressure pipe and Amargosa gravity pipe would extend in parallel approximately 1,500 feet along the hillside that flanks the northern edge of Amargosa Creek to 25th Street West, where both pipes would extend as individual culverts beneath 25th Street West to its eastern side. The culvert pipes may be able to be installed beneath 25th Street West by means of horizontal boring machinery to eliminate the need for road excavation and traffic control. An alternate route for the SWP pressure pipe could include an alignment from the proposed tap, 3,200 feet along the north side of Elizabeth Lake Road, then northward 400 feet, crossing Amargosa Creek on the upstream side of the 25th Street West Bridge with pipe hangers, to the proposed culvert street crossing.

Amargosa Creek Gravity Pipe

Invert elevations and slope of the Amargosa gravity pipe would be set to produce sufficient head for gravity flow to all recharge basins east of 25th Street West and sufficient velocity to self-cleanse sediment from the pipe, if possible. Manholes and/or cleanouts would be provided at regular intervals along the entire length of Amargosa gravity pipe to provide a secondary means of cleaning out sediment. Final pipe design would consider elevation of the proposed Amargosa Creek diversion structure and elevations of existing buried utilities that parallel 25th Street West, while allowing sufficient pipe cover at the 25th Street West crossing.

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Settling Basin

Water flow from both the pressure and gravity pipe culverts beneath 25th Street West would be directed into a proposed settling basin located immediately east of 25th Street West. The settling basin would be sized to allow sediment to settle out of water diverted from Amargosa Creek (expected to contain considerable amounts of sediment during high flow conditions) prior to the water being conveyed under gravity flow conditions into any of the five off-channel recharge basins. Basin inflow from the Amargosa gravity pipe would be controlled with a concrete gate structure containing a slide or flap gate mechanism. The gate would be controlled by a manual gate lift (handwheel or crank) or by a power-actuated gate lift (hydraulic or electric). The settling basin would also receive flow from the SWP pressure pipe allowing the pressure flow energy to be dissipated into open channel gravity flow for subsequent delivery to the five off-channel recharge basins. Basin inflow from the SWP pressure pipe would be controlled by a manual or power-actuated valve. Rip-rap energy dissipaters would be installed in the settling basin at both pipe outlets to control basin erosion at the inflow.

Eastern Pipeline and Basin Inflow

Water detained in the proposed settling basin would exit the basin through a proposed concrete gate structure controlling open channel flow into a proposed gravity flow pipeline (eastern pipeline) to any of the five off-channel recharge basins. The eastern pipeline would extend from the northwest corner of the proposed settling basin near 25th Street West along the entire northern project property boundary (generally eastward 1,000 feet, then northward 1,000 feet, then eastward 1,000 feet) to its terminus near the extreme northeast corner of the project property boundary at Amargosa Creek. Invert elevations and slope of the pipeline would be set to produce sufficient head for gravity flow to any of the five off-channel recharge basins. Five concrete gate structures similar to those described for the proposed settling basin would be provided for each of the five recharge basins to control individual basin inflow from the eastern pipeline, allowing any basin(s) to be isolated from operations and left dry for maintenance purposes while all other basins continue to receive water. One similar concrete gate structure would be provided at the terminus of the eastern pipeline for control and discharge of pipe return flows into Amargosa Creek. Rip-rap energy dissipaters would be installed in all five off-channel recharge basins at the proposed inflow gates and at the proposed pipe discharge into Amargosa Creek to control erosion.

Basin Interflow and Outflow

The five proposed off-channel recharge basins would be isolated from one another with three interior earthen berms and would be separated from Amargosa Creek by exterior berms.

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Three concrete gate structures similar to those described previously would be installed on the three interior berms to provide additional control of water flow between individual basins. Five concrete gate structures similar to those described previously would be installed on the five exterior berms with piped drop structures to allow basin return flows into Amargosa Creek. Rip-rap energy dissipaters would be installed on the discharge end of all return flow gates to control erosion along Amargosa Creek. Emergency spillways would be constructed on all five exterior basin berms to prevent excess inflow from overtopping the berms and reduce potential basin failure. Excess inflows would be discharged from the emergency spillways to the Amargosa Creek channel.

Flow Measurement

Flow measurement devices would be installed at key locations to monitor flow rates into and out of the water conveyance system. Key locations for flow measurement devices would include the SWP pressure tap, the Amargosa Creek diversion, the eastern pipe return flow to Amargosa Creek, all recharge basin inflow and outflow control gates, and on Amargosa Creek upstream and downstream of the project area. Flow measurement devices could include meters, weirs, flumes, recording, and/or staff gages.

Stormwater Conveyance

Storm flow from residential areas northwest of the project site is conveyed through an existing stormwater culvert beneath 25th Street West onto the project site, discharging near the northwest corner of the project property boundary at 25th Street West near the proposed settling basin. This has formed a channel, up to ten feet deep, that generally extends from the culvert discharge in a southeasterly direction to Amargosa Creek. The project would include a 500-foot stormwater conveyance pipe connected to the 25th Street West storm culvert and extended in a southerly direction parallel to 25th Street West to Amargosa Creek, directing upslope storm flow away from project facilities. A rip-rap energy dissipater would be installed at the discharge point to control erosion. Standard surface stormwater and erosion control methods would be used for all other areas on the project site.

As an option, the project could include stormwater collection and conveyance facilities that would direct existing upslope municipal storm flow into the proposed recharge basins rather than directing the storm flow away from project facilities directly into Amargosa Creek. This option would increase the recharge of local storm flow; however, water quality of the storm flow could present problems with the recharge process. Relatively high temperatures and high concentrations of suspended solids and certain chemical constituents in the storm flow may adversely impact basin recharge rates due to chemical reactions between the water, native soils, and living organisms in the soil. Therefore, water quality of municipal storm flow should

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be evaluated prior to preliminary design activities that would incorporate storm flow into recharge facilities.

REFERENCES

2006, West Consultants, Inc., *Hydraulic Analysis and Scour Evaluation for the 20th Street Bridge Over Amargosa Creek*, City of Palmdale, CA.

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TECHNICAL MEMORANDUM

TO: Gordon Phair, P.E. (City of Palmdale)

FROM: Thomas Mulroy, Ph.D. (SAIC)

RE: Amargosa Creek Recharge Project - Habitat Restoration and Enhancement Design Rationale

DATE: January 03, 2008

INTRODUCTION

The Amargosa Creek Recharge Project site has been divided into several zones with differing habitat design considerations. These zones include a Heritage Habitat preservation and enhancement area (H); Stable riparian terrace and road embankment (S); Intermediate riparian terrace (I); and Active riparian terrace (A) [Figure 3]. The assignment of areas to their respective zones was based on two site visits and topographic interpretation of ground surface contours. The assignments and design considerations are subject to change as more information is developed about the hydrology and potential for overbank flow at this site. Preliminary design considerations for the mapped zones are described in the following sections.

UNDERLYING DESIGN CONSIDERATIONS

Native desert shrubs (i.e. sagebrush type plants, Joshua trees, cacti) are adapted to survive on incident precipitation. Some desert species require a little more water than others, limiting them to draws or depressions where there is slightly higher soil moisture compared to flats or hills. Many desert species are relatively slow growing and take many years (or decades) to reach maturity. They provide food, cover, and burrowing or nesting sites for native wildlife species, including birds, small mammals, and reptiles. Most upland desert species have limited tolerance of flooding. Many of the native desert plants have seasonally attractive ornamental characteristics, and mature specimens may have interesting characteristics such as unusual bark or striking growth forms.

Given adequate water, native riparian trees such as willows and cottonwoods are well adapted to grow in this region, are attractive, provide excellent habitat value, and transpire freely (causing water losses) when in leaf, roughly March-October. In addition to providing habitat value, this type of tree could be beneficial as a naturalistic, meandering screening of the recharge areas. Riparian species provide cover and food for migrating songbirds and provide nesting habitat for several resident bird species.

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Wherever possible, existing native plant species would be conserved on site, with priority going to those species with the longest lifespan and which require the greatest time to establish and reach maturity. For example, onsite preservation priority would go to species such as Joshua tree, California juniper, Mormon tea, and peach thorn. These species represent hundreds of years of growth on site, are adapted to local climatic and hydrologic conditions, and take decades to attain their current stature, habitat value, and aesthetic value in the landscape. These mature specimens also provide excellent educational interpretative value. It is also desirable to conserve other native shrub species, including big sagebrush, fourwing saltbush, creek senecio, and cotton thorn, although these establish more readily and grow faster, potentially reaching normal stature within 5-10 years.

Plants used in the habitat restoration would emphasize species native to the Amargosa Creek watershed, including portions upstream from the project site where species diversity is higher than on site (Table 1). Use of native species provides interpretive possibilities as well as ensures adaptation to onsite conditions. Some supplemental irrigation would be required during the establishment period and may be desirable to keep the specimens in top condition.

HERITAGE HABITAT PRESERVATION/ENHANCEMENT AREA (H)

This existing 3.2-acre area of mature upland desert scrub is dominated by long-lived native species including Joshua trees, California junipers, Mormon tea, peach thorn, and four-wing saltbush. These species are well-established, in good condition, and offer excellent interpretative opportunities. It would take many decades to reproduce this habitat if starting from bare ground. The adjacent Amargosa Creek channel allows for free movement of many wildlife species, increasing the value of the Heritage Habitat area for wildlife. There is considerable accumulation of refuse and debris from human uses and there are some areas where vegetation has been removed as a result of human activities.

Recommended actions:

- Preserve and enhance existing habitat in this area;
    - Remove refuse;
    - Selectively add native plants to bare areas;
- Provide for limited public access to facilitate interpretation while minimizing the effects of access on vegetation and wildlife;
    - Fence the area to impede vehicular and pedestrian access;
    - Provide for "lollipop trails" leading from the perimeter of the habitat into the habitat for close viewing of specific features of interpretive interest.

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STABLE RIPARIAN TERRACE AND ROAD EMBANKMENT (S)

This 13.1-acre area is sparsely to moderately vegetated with native species and contains many bladed or otherwise barren surfaces related to previous human disturbances. Existing engineered features include a sewer line with manhole covers, outflows from stormwater culverts, the Elizabeth Lake Road embankment, and a small concrete apron. There are also unimproved roads, paths, and bladed areas. The Elizabeth Lake Road embankment is engineered, mostly stable except for rill erosion in some areas, and has a sparse to moderately dense cover of low shrubs, dominated by four-wing saltbush.

Incorporating road embankments into the restoration effort provides opportunities for establishing large shrubs characteristic of more mesic, north-facing slope conditions that would also provide a visual buffer between the site and the road. Examples include squawbush, desert olive, quailbush, California juniper, and birchleaf mountain mahogany. There are a few remnant California junipers and Joshua trees on site that should be retained in the design.

The Stable Riparian Terraces would have four basic planting zones:

S-1. Woody native desert scrub established around remnant Joshua trees and California junipers;

S-2. Native riparian tree species established around the outflows of two culverts crossing the terrace from south to north;

S-3. Large native shrubs planted on base of the embankment acting as a screen or buffer;

S-4. Low shrubby native species established initially on more bare areas.

Because of its elevation, the Stable Riparian Terrace zone is infrequently flooded and flood-intolerant desert shrub species would be planted here. Amenities susceptible to flood damage would be concentrated in this zone, including picnic tables, benches, shade structures (ramadas), and, wherever possible, the multi-use bike path. This zone represents the core of the Nature Park aspect of the recharge project (Figure 5).

Recommended actions:

- Preserve existing long-lived species on site (some Joshua trees and California junipers);
- Extend the coverage of similar arborescent desert vegetation from these preserved plants by planting out Joshua trees from the holding area and planting out compatible native species propagated from locally collected seed or cuttings;

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- On relatively bare areas and shallow soils, establish a low-desert scrub using species such as California buckwheat, four-wing saltbush, rubber rabbitbrush, and cotton-thorn;
- Establish both long-lived and shorter-lived native upland plants using supplemental irrigation;
- Construct the majority of engineering amenities in this zone, including ramadas, picnic tables, drinking fountains, and the multi-use bike path;
- Establish interpretive centers, including storyboards, about water supply, the function of percolation basins, the watershed, desert vegetation, and wildlife.

INTERMEDIATE RIPARIAN TERRACE (I)

This 5.1-acre zone is sparsely to moderately vegetated with native species, and contains many bladed or otherwise barren surfaces related to previous human disturbances. Although flooding would be expected to occur more frequently than in the Stable Riparian Terrace zone discussed above, there are a few remnant individuals of long-lived native shrub species including Joshua tree and California juniper. The outflows from two stormwater culverts cross this zone and convey drainage from housing developments to the south across the Intermediate Terrace. Although the volume of flow is small, these outflows provide opportunities to develop localized riparian woodland centered around native riparian trees and shrubs already established. This habitat type will provide suitable habitat for a variety of bird species, including neotropical migrant songbirds that winter in tropical habitats and breed in North America (Figure 6).

Recommended actions:

- Establish perennial native upland plants, primarily low to medium shrubs, using supplemental irrigation;
- Consider establishing longer-lived upland plants around existing Joshua trees and junipers;
- Establish riparian trees at localized points of inflow, selecting among naturally establishing trees to result in a few larger individuals rising above the existing shrubby growth;
- The multi-use bike path would traverse this zone in select areas.

ACTIVE RIPARIAN TERRACE (A)

This 4-acre zone is sparsely vegetated with mostly fast growing native shrubs such as rubber rabbitbrush that can rapidly colonize bare soils. This zone contains barren surfaces

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related to previous human disturbances. Although flooding would be somewhat more likely than in the previously described zones, it is expected that flood-free intervals would be sufficient to allow growth of a stable cover of native shrubs.

Recommended actions:

- Establish perennial native upland plants, primarily low to medium shrubs, using supplemental irrigation, placing emphasis on species that establish quickly and can be easily reseeded;
- Species need compatibility with periodic disturbance, further investigation into flood frequency is needed;
- This zone would contain minimal infrastructure.

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TECHNICAL MEMORANDUM

TO: Gordon Phair, P.E. (City of Palmdale)

FROM: Drew Beckwith, Brad Newton, Ph.D., P.G. (SAIC)

RE: Amargosa Creek Groundwater Recharge Project - Institutional Considerations

DATE: January 02, 2008

INTRODUCTION

The institutional considerations activity was intended to provide a review and analysis of local and state institutional and regulatory requirements that will affect project implementation. This task includes: (1) research and planning related to development of strategic partnerships with State Water Project (SWP) contract holders who may want to "bank" any unused allocation of their water supply from the California Aqueduct in the Antelope Valley aquifer via City facilities; (2) preparation of drafts of memoranda or principles for agreements with entities interested in entering into arrangement with the City for operation of the recharge facilities for groundwater recharge, banking, extraction, distribution, and any other potential beneficial uses; (3) review requirements for permitting the facilities with appropriate entities such as CA Dept. of Fish and Game; and, (4) review requirements regarding groundwater recharge with Lahontan Regional Water Quality Control Board.

ON-GOING ACTIVITIES

Based on discussions with representatives of the City of Palmdale on October 24th, 2007, tasks (1) and (2) mentioned above, will be postponed until the project is further defined. Presented in the following sections are some of the institutional considerations to be addressed prior to, and possibly during, project implementation.

CEQA REVIEW

A government activity in the State of California is subject to CEQA if it involves the exercise of an agency's discretionary powers, has the potential to result in a direct or reasonably foreseeable indirect physical change in the environment, and falls within the definition of a project as defined by the CEQA Guidelines (CEQA Guidelines Section 15378). The Amargosa Creek Recharge Project involves the exercise of the City of Palmdale's discretionary powers, will result in a direct physical change in the environment, and falls within the definition of a project as an activity directly undertaken by a public agency, including: public works construction activities and clearing or grading of land. Therefore, a preliminary review and

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Initial Study must be performed to determine if the project will have a significant impact and be subject to further CEQA requirements (CEQA Guidelines Section 15063).

LAHONTAN RWQCB REQUIREMENTS

Currently, the Lahontan RWQCB does not regulate groundwater recharge projects involving raw SWP water or natural runoff. Groundwater recharge projects involving recycled water or chlorinated water are subject to a permitting process. Multiple recharge projects constructed by the Mojave Water Agency for recharging SWP water in basins along the Mojave River have not been subject to permitting by the Board. Under federal Clean Water Act (CWA) section 401 every applicant for a federal permit or license for any activity which may result in a discharge to a water body must obtain State Water Quality Certification (Certification) that the proposed activity will comply with state water quality standards.

DEPTARTMENT OF FISH AND GAME

The placement of push-up dams within the Amargosa Creek bed will require a Stream Bed Alteration Agreement from the Department of Fish and Game. In order to begin the application process for this Agreement, a complete draft of the environmental documentation required by CEQA is necessary.

STATE WATER RESOURCES CONTROL BOARD

Diversion of waters from Amargosa Creek into City recharge facilities will require a permit from the State Water Resources Control Board.

COURT

The Antelope Valley Groundwater Basin is currently under litigation. Any judgment, settlement, or stipulation pursuant to the litigation will supersede proposed activities herein.

FUNDING

Considerations for funding include the City of Palmdale, MOUs, and local/regional partnerships. These will need to be determined before moving forward.

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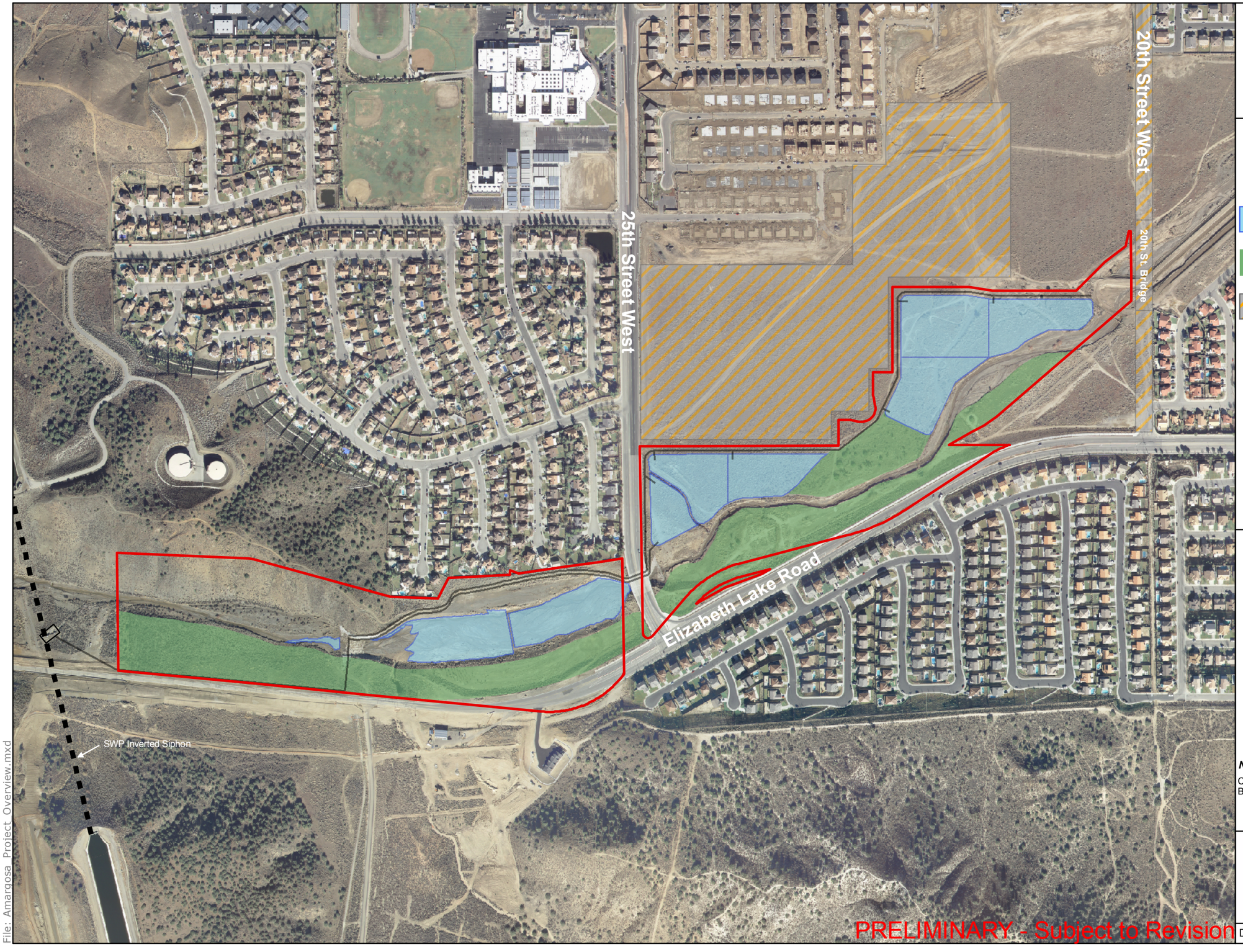
Amargosa Creek Recharge Project

- Conceptual Design -



- Parcel Boundary (74.9 acres)
- Conveyance Facilities
- Recharge Facilities (18.9 acres)
- Habitat Mitigation Area (25.4 acres)
- Off-Site Construction Zone

0 250 500 750 1,000

Feet

N

NOTES:

Coord Sys: State Plane NAD 83 Zone 5 U.S. Foot
Basemap: LARIAC 4-in resolution Airphoto, 2006

SAIC® From Science to Solutions

FIGURE: 1

DATE: 12/10/07 | BY: D Beckwith

File: Amargosa Project Overview.mxd

Water Resource Infrastructure

Amargosa Creek Recharge Project
- Conceptual Design -

- Parcel Boundary (74.9 acres)
- Recharge Basin (17.7 acres)
- Settling Basin (1.2 acres)
- Off-Site Construction Zone
- Gravel Push-Up Dam
- Conveyance Pipe
- Storm Drain with Outlet Structure
- Basin Inlet Pipe/Valve with Flow Measurement
- Interpond Pipe/Gate/Weir with Flow Measurement
- Return Flow Pipe/Gate/Weir with Outlet Protection/Flow Measurement
- Stream Diversion Intake Structure/Headgate
- Flow Measurement Device

0 250 500 750 1,000

Feet

N

NOTES:

Coord Sys: State Plane NAD 83 Zone 5 U.S. Foot
Basemap: LARIAC 4-in resolution Airphoto, 2006

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FIGURE: 2

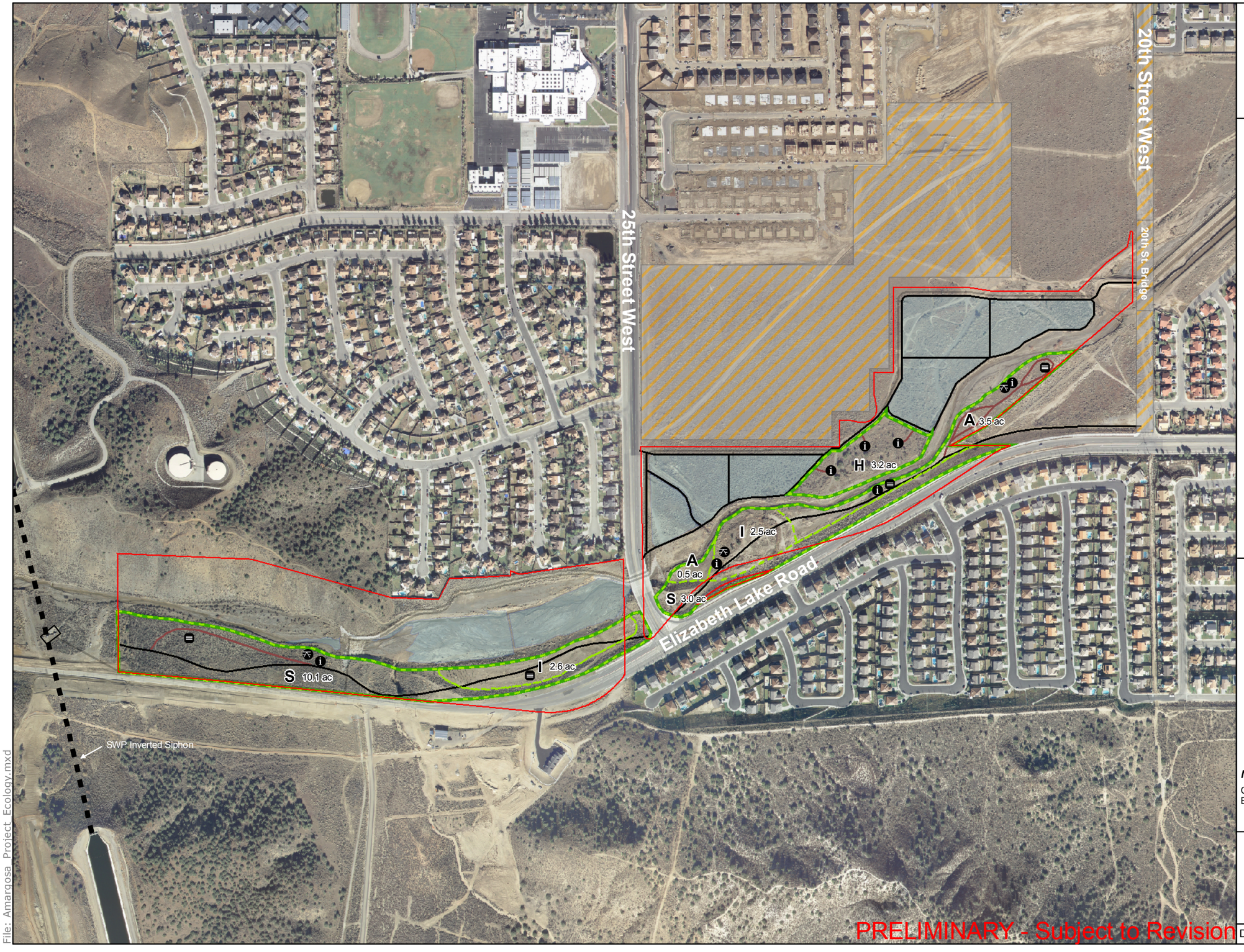
DATE: 12/10/07 | BY: D Beckwith

PRELIMINARY - Subject to Revision

File: Amargosa Project Engineering.mxd

Amargosa Creek Nature Park

Amargosa Creek Recharge Project
- Conceptual Design -



- Parcel Boundary (74.9 acres)
- Habitat Mitigation Area (25.4 acres)
- H — Heritage Habitat Preservation/ Enhancement Area (3.2 acres)
- A — Active Riparian Terrace (4.0 acres)
- I — Intermediate Riparian Terrace (5.1 acres)
- S — Stable Riparian Terrace and Road Embankment (13.1 acres)
- Off-Site Construction Zone
- Multi-Use Bike Path with Solar-Powered Lights (2.5 miles)
- Foot Path (0.5 miles)
- Education Station with Interpretive Plaque
- Picnic Table
- Ramada

0 250 500 750 1,000
Feet

NOTES:

Coord Sys: State Plane NAD 83 Zone 5 U.S. Foot
Basemap: LARIAC 4-in resolution Airphoto, 2006

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DATE: 12/10/07 | BY: D Beckwith

FIGURE: 3

PRELIMINARY - Subject to Revision

File: Amargosa Project Ecology.mxd

Figure 4

Push-Up Dam and Intake Structure

Figure 5

Heritage Habitat Overlook

Figure 6

Habitat Enhancement on Terrace

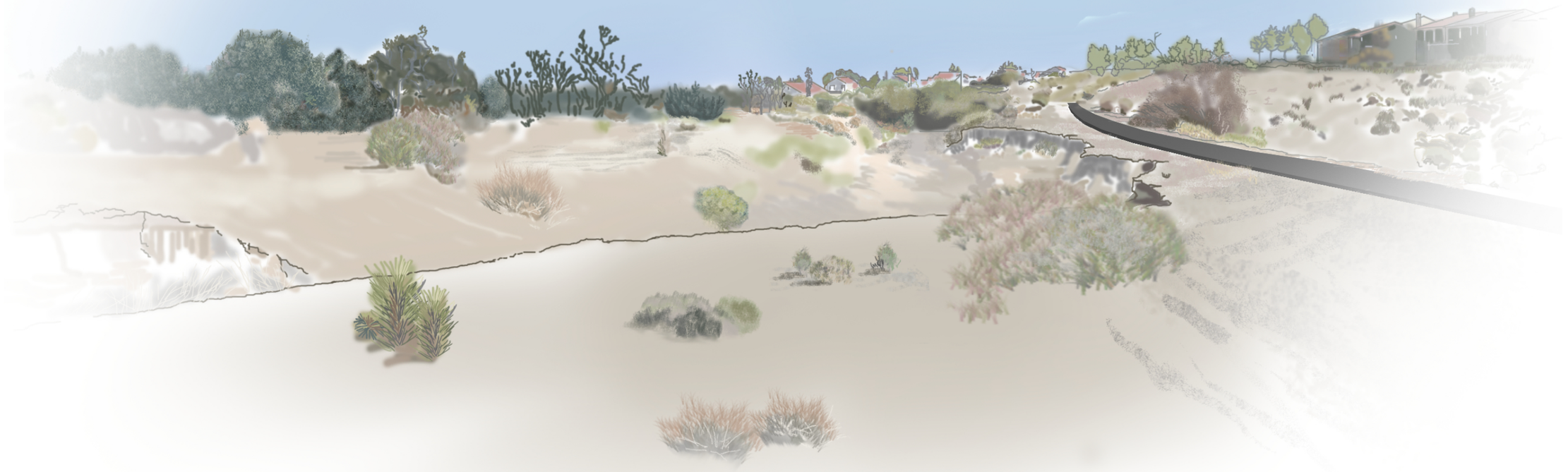

Table 1. Preliminary List of Species to Use in Habitat Enhancement

Species Common name *(Scientific name)*	Growth Form	Heritage Habitat	Stable Terrace/ Embankment	Intermediate Terrace	Active Terrace	Comments
California juniper* *(Juniperus californica)*	Large shrub	X	X	X		Preserve onsite wherever possible.
Joshua tree* *(Yucca brevifolia)*	Large shrub[1]	X	X	X		Preserve onsite wherever possible.
Mohave yucca *(Y. shidigera)*	Large shrub[1]					Omit if not present in the project vicinity.
Birchleaf mountain mahogany *(Cercocarpus betuloides)*	Large shrub		X			Could be used at base of road embankment.
California buckwheat *(Eriogonum fasciculatum var.)*	Low shrub	?	X	X	X	
Big sagebrush* *(Artemisia tridentata subsp.)*	Medium shrub	X	X	X		
Rubber rabbitbrush* *(Chrysothamnus nauseosus subsp.)*	Low to medium shrub	X	X	X	X	
Yerba santa* *(Eriodictyon crassifolium)*	Medium shrub	X	X	X	X	
Cotton thorn* *(Tetradymia sp.)*	Medium shrub	X	X			
Creek senecio* *(Senecio flaccidus var. douglasii)*	Slender shrub		X	X	X	
Silver cholla* *(Opuntia echinocarpa)*	Medium cholla cactus	X	X	X		Interpretive value. Wildlife uses.
Peach thorn* *(Lycium cooperi)*	Large thorny shrub	X	X	X		Preserve onsite wherever possible.
Mormon tea* *(Ephedra sp.)*	Low spreading shrub	X	X	X		Preserve onsite wherever possible. Accumulates sand around its base
Four-wing saltbush* *(Atriplex canescens)*	Medium shrub	X	X	X	X	Abundant on site, some planted on road embankment. Heavily browsed by rabbits.
Sage *(Salvia dorrii pilosa)*	Low to medium shrub					Suitability for site needs further investigation.
Paper bag bush *(Salazaria Mexicana)*	Low to medium shrub					Suitability for site needs further investigation.
Indigo bush *(Psorothamnus sp.)*	Medium shrub					Suitability for site needs further investigation.
Desert olive *(Forestiera neomexicana)*	Large shrub[2]		X			Could be used at base of road embankment.
Squawbush *(Rhus trilobata)*	Large shrub[2]		X			Could be used at base of road embankment.
Quail bush *(Atriplex lentiformis breweri)*	Large shrub		X			Suitability for site needs further investigation.

Species Common name *(Scientific name)*	Growth Form	Heritage Habitat	Stable Terrace/ Embankment	Intermediate Terrace	Active Terrace	Comments
Velvet ash (*Fraxinus velutina* subsp. *coriacea*)	Deciduous tree[2]			X		Not native to Amargosa Creek watershed. Extensively planted locally as a landscape tree. Would be planted only at drainage inflows.
Desert needlegrass *(Achnatherum speciosum)*	Native bunchgrass					Suitability for site needs further investigation.
Indian ricegrass *(Achnatherum hymenoides)*	Native bunchgrass					Suitability for site needs further investigation.

Notes:

(1) Check local policies concerning salvaging slow-growing yucca species and cactus species as young plants from developing properties and transplanting them to the landscape site.

(2) Plants with higher water requirements that may be suitable adjacent to points of inflow where native riparian plants, including willows (Salix exigua*, Salix gooddingii*, Salix laevigata*), Fremont cottonwood (Populus fremontii*) and seep willow (Baccharis salicifolia*), are currently establishing.

* Species observed on site on Oct 2 or 17, 2007